WASTEWATER REUSE LAW AND STANDARDS IN THE KINGDOM OF JORDAN

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THE MINISTRY OF WATER AND IRRIGATION

AMMAN, JORDAN

MARCH, 2000

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Abstract

The Hashemite Kingdom of Jordan has a critical shortage of water resources. Water use per capita is among the lowest in the world and urban population continues to grow, increasing water demand. The government of Jordan has been quick to recognize the potential of wastewater reuse to expand the existing supply of water. Today nearly all the wastewater generated within the Kingdom is reused after appropriate treatment and blending with higher quality water. Planning is underway for further optimization of recycled water.

The successful utilization of recycled water within Jordan has been made possible by the development and evolution of a sound legislative and legal foundation. There are several sets of standards that have paved the way. These include the first law regarding the operation of municipal sewer systems, which was first established in 1955, and the original public health standards first enacted in 1971.

The reuse of wastewater is now regulated by several sets of standards: including one governing the discharge of toxic materials to sewers and others that established standards for reuse of wastewater and the processing and use of sludge.

Progress in wastewater reuse in Jordan has been significant. Initiatives are underway to further enhance the framework of laws and standards for improved integration of the treatment requirements for the wastewater with the likely reuse of the treated effluent in order to minimize the treatment costs, ensure public health and preserve the environment. Further evolution of the legislation may also allow for more flexible decision-making processes, and higher-value uses of treated wastewater.

The paper traces the history and development of wastewater regulatory laws and the agencies that control wastewater within Jordan. The authors trace the development of the law underlying the wastewater agencies and the related standards and rules, and they provide some insights into the opportunities for the future evolution of Jordan's wastewater reuse laws and standards.

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1.0 Introduction

The Kingdom of Jordan is a semi-arid country of about 4.6 million population where the demand for water often exceeds the available supply. On a per capita basis, Jordan has one of the lowest available water supplies in the world. The annual per capita water budget is about 180 cubic meters per person per year and the net amount of water available per person is expected to fall as population grows. This compares to about 950 cubic meters per person per year in Egypt and about 400 cubic meters per person per year in Israel.[1] Jordan receives an average of about 75 mm of rainfall per year with regional variations from about 50 mm per year in the southern deserts to over 600 mm per year in the mountains northeast of the Jordan Valley.

Around 78% of the population of Jordan live in the urban areas in four governorates: Amman, Irbid, Zarqa, and Balqa. Waves of refugees and those returning from the Gulf during the war in 1991 added substantially to the pressure on the environment and resources of the Kingdom. The approximate national water budget during 1998 is shown in Table 1.

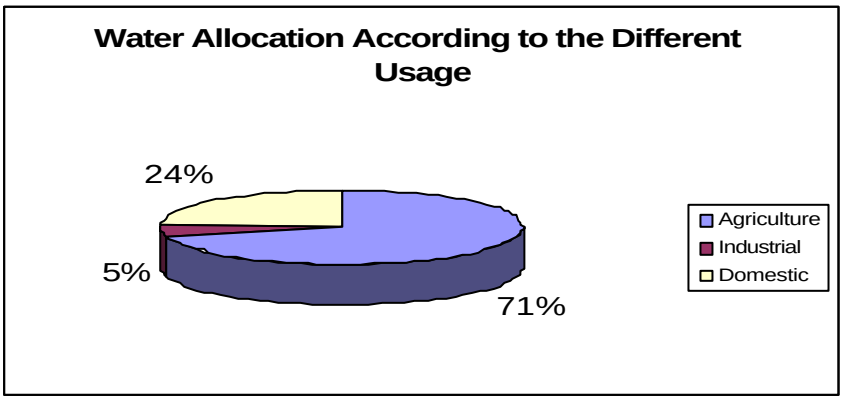
Table 1: Water Used in Jordan in 1998 by Source

	Quantity MCM/yr.
Surface water sources	375
Ground water sources	470
Reclaimed wastewater	70
Total Approximate Annual Water Supply	915

One MCM = one million cubic meters

Jordan has been forced to rely on non-renewable groundwater reserves to meet the rising demand for water as population and industrial use of water grew rapidly during the past decades. Some aquifers are being drafted at rates that are well beyond their sustainable yields resulting in declines in water level and lowered water quality. As in most arid countries, agriculture demands the largest share of the available water in Jordan. Currently, agricultural use of water is estimated to be 73% of the total water used in the nation. Figure 1 illustrates the allocation of water use in Jordan.

Figure 1. Allocation of Water in Jordan in 1999



[1] World Bank; *Water Sector Review, 1997*

1.1 The Wastewater Resources of Jordan

The Government of Jordan is currently operating 17 wastewater treatment plants serving roughly 2.3 million people[1], about half of the nation's population. The balance of the population relies on cesspools and soakaways. In 1999 the total quantity of treated effluent produced from all treatment plants was about 70 million cubic meters per year (MCM.)

About 75% of the annual national budget of reclaimed wastewater (55 MCM) is produced by the Khirbit As Samra wastewater treatment plant which receives wastewater from the cities of Amman, Zarqa and Russaifa. The plant, located about 30 kilometers northeast of Amman, is one of the largest waste stabilization ponds in the world. The anaerobic stabilization ponds at the plant provide treatment to about 150,000 cubic meters of wastewater during the average day. The treated effluent is discharged to Wadi Dhuleil and, subsequently, to Wadi Zarqa where dissolved oxygen levels are improved. The effluent flows join with the natural runoff of Wadi Zarqa. About 35 kilometers downstream, the flow of Wadi Zarqa is impounded and detained for an average period of several weeks at the King Talal Reservoir.

Due to the moderate salinity of the domestic water supplies in Jordan, the wastewater received at treatment plants has total dissolved solids (TDS) ranging from about 700 to over 1000 parts per million. (ppm) Domestic wastewater in Jordan is more concentrated than the wastewater of water-rich countries due to water shortages and water conservation practices. The biochemical oxygen demand (BOD) of Khirbet As Samra wastewater is on the order of 700 milligrams per liter (mg/l), about twice as high as in the United States, and the ammonia levels are substantially higher than in many countries. Wastewater received by other treatment plants is even more concentrated.

Jordan's Ministry of Water and Irrigation is in the process of upgrading the capacity and quality of wastewater treatment plant at Khirbit As Samra. The capacity of the plant is expected to rise to nearly 65 MCM by 2003 and the quality of the treated effluent will also improve markedly as the new As-Samra wastewater treatment facilities come on-line. As-Samra now has a detention time that is sufficient to reduce helminth eggs and most other pathogens to low levels. Future wastewater flows from Amman-Zarqa region may be as high as 147 MCM per year by 2015 and 231 MCM by 2025. [2]

At present, there are 16 other treatment plants serving the smaller communities of Jordan with a combined design capacity of about 70,000 cubic meters per day, or about 26 MCM per year. The largest of these wastewater treatment plants serves the town of Irbid north of Amman. The mechanical plant at Irbid has a capacity of about 11,000 cubic meters per day, or about 4 MCM per year. [3]

Five of the smaller wastewater treatment plants in Jordan use waste stabilization ponds that provide long detention periods and good reduction of pathogens. The mechanical plants have polishing ponds, chlorination and detention for helminth egg removal and further reduction of fecal coliform and related pathogens. Several private wastewater treatment facilities are operated in Jordan under government supervision including an efficient plant at Queen Alia Airport.

2.0 The Wastewater Reuse Standards and Law

Recycling of water is a necessary component of water resources management in Jordan where the supply of water is very limited and the demand is rapidly increasing. Yet, water recycling presents some risk to public health and the environment, and it is perceived negatively in the public eye. A prerequisite to the successful management of the recycled water and the enhancement of public confidence is the establishment of a practical framework of regulations and laws that help ensure public health and low environmental impact. The legal framework must also be flexible enough to adjust to local conditions and the economic fundamentals of the situation. Laws and standards for wastewater reuse must also be able to evolve to changing physical, social, economic and environmental conditions. Wastewater professionals and government officials in Jordan have made significant progress in developing a rational basis for optimization of this important resource.

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1 Water Authority of Jordan; Wastewater *Annual Report for 1999*
2 Harza Engineering; *Master Plan and Feasibility for Wastewater, Amman Zarqa; 1997*
3 The Ministry of Water and Irrigation; *Wastewater Management and Reuse – Country Report; 1999*

2.1 Some Historical Aspects of Wastewater Laws and Standards in Jordan

The Ottoman Sultan Abdul Hamid II enacted the first water law in the region. The law provided the basis for the resolution of disputes over water and land ownership. The main principles of this law survived in Jordan and they were captured in the 1952 Law of Water and Land Settlement. Wastewater collection has been practiced in Jordan in a limited way since 1930 beginning in the town of Salt, about 30 kilometers west of Amman. Some wastewater treatment was achieved using primitive physical processes. Generally septic tanks and cesspits were used and grey water was often discharged to gardens. This practice resulted in environmental and public health problems as populations grew.

Municipality Law #29/1955, enacted in 1955, gave the government authorities of Amman, and other legally formed municipalities, the legal capacity to own and operate water systems and to specify standards for water system construction and to set fees for water use. The law also specifically entrusted the municipal government's water agency with the responsibility to "prevent the pollution of water supply springs, canals and basins or wells." The 1955 law also provided the government the powers to construct public sewers and to undertake the "management and supervision of the sewers." This enabling legislation applied only to the defined area of the municipality. Interestingly, the legislation gave the municipalities the authority, with the approval of the Cabinet, to develop concessions for operation of public utilities by private-sector engineers and contractors so long as such concessions did not exceed 30 years.

The Natural Resources Agency was created in 1965 to manage the development and conservation of Jordan's natural resources. Ultimately, the agency was given powers over mineral and petroleum resources as well as setting policy on water resource development and irrigation.

In 1966 the Government of Jordan adopted the Buildings, Rural and Urban Planning Law No. 79/ 1966 The code empowered government agencies with the capacity to regulate "the dispostion, collection or discharging of wastewater" that might cause a nuisance or damage. The ordinance gave the municipal or district commission the authority to issue a notice of harm or damage and to order the responsible person to correct the situtation within the period specified in the notification. Under the law, if the person responsible failed to correct the situation, the Commission was granted the power to undertake the work and collect the cost of such work in the courts. A daily fee of up to 5 Jordanian Dinars could be levied during the violation period.

The basic public health framework for wastewater control was established by Public Health Law No. 21 enacted in 1971. The law gave the Ministry of Health the authority to monitor and regulate wastewater discharges and the design of wastewater facilities. Article 33 of the Public Health Law No. 21 made it necessary for developers to build all sewers and treatment plants according to the standards issued by the Ministry of Health. The law also regulated the development of sewers in new municipal areas. The Ministry of Health was given the power to approve plans and specifications for sewers and treatment plants and to supervise all sewer and treatment plant construction. Article 35 of the Public Health Law No. 21/1971 also limited the number of connections that could be made to any particular treatment plant or sewer in accordance with the accepted and approved design.

Public Health Law No. 21/1971 provided the Ministry of Health with the powers to monitor and regulate wastewater and its treatment and disposal. These powers still exist today under the law. Article 30 of the Public Health Law No. 21 enacted in 1971 made it illegal for tankers to discharge sewage and septage in places not assigned for the purpose. The law also included penalties for person causing a health nuisance to prison terms ranging from a week to one year or fines of up to 200 Jordanian Dinars.

In 1977 the Jordan Valley Authority was created by Law # 18/1977. Under this law, the agency gained substantial power to plan and execute wastewater and water supply projects in the Jordan Valley. Later, under law #19/1988, the Jordan Valley Authority consolidated its control over the development and operation of infrastructure in the Jordan Valley. Over the years, the Jordan Valley Authority has directed the development of wastewater systems in the valley and built an advanced water and wastewater management system.

During the period from approximately 1982 until 1989, Jordan was ruled under martial law. In 1982, in response to the impact of a relatively small but rapidly developing industrial sector, Martial Law

#2/1982 was enacted. This law was specifically targeted at controlling discharges from industries into the natural water system, particularly in the Amman-Zarqa basin, where the majority of the population and development was concentrated. The law established the first set of broad standards for wastewater reuse.

Later, in 1983, Temporary Law #34/1983, established a national Water Authority. The new agency was to be created by combining the Amman Water and Sewage Authority, the Drinking Water Corporation, that managed water supply in the governorates, and the other municipal water utilities. After the consolidation, the Water Authority of Jordan (WAJ) began to develop nation-wide standards for water and wastewater.

In 1988 the Government of Jordan moved to further consolidate control of water resources under the Water Authority of Jordan. Under Law 18/1988 the Amman Water and Sewerage Agency and the water resource sections of the Jordan's Natural Resources Agency were also incorporated into the national water authority. This effectively combined the water resource exploration, planning and information sections of the government with those working on water supply. WAJ was tasked with the provision of water and sewer systems and the management of the nation's water resources. According to the legislation, the Water Authority of Jordan (WAJ) was to formulate water and wastewater policy and to plan the development of water resources. WAJ also had responsibility for monitoring of water and wastewater projects. In its capacity as the water resource authority of Jordan, the WAJ now has extensive powers to regulate the treatment of wastewater.

In a further move to consoldiate control over water resources and to achieve policy alignment, the government of Jordan created the Ministry of Water and Irrigation (MWI) in 1992 under by-law # 54/1992. The MWI was created to centralize and improve the management or the nation's critically short water resources under one minister. The Ministry of Water and Irrigation legislation centralized the control of water resources that were formerly regulated by several agencies with different mandates including the Jordan Valley Authority, the Water Authority of Jordan, the Ministry of Agriculture and the Ministry of Health. The comprehensive MWI gained substantial power to allocate, and regulate the water resources of Jordan and to resolve differences among agricultural users, water supply authorities, and wastewater treatment and reuse activities.

3.0 CURRENT NATIONAL WASTEWATER STANDARDS

Today there are several sets of standards and criteria for wastewater and sludge that were derived from the work of the Water Authority of Jordan and the Ministry of Water and Irrigation. The existing standards and laws that directly apply to wastewater reuse are the Water Authority of Jordan Law #18/1988, the Jordan Standard #202/1991 for Industrial Wastewater Discharges, Jordanian Standard 893/1995 for Discharge of Treated Domestic Wastewater, and Jordanian Standard # 1145/1996 regarding the use of sludge.

3.1 Water Authority of Jordan Law #18/ 1988

In 1987 and 1988, the Water Authority of Jordan developed a comprehensive law, WAJ Law No. 18/1988, to control industrial discharges to public sewers. The current law, the "Instructions for Commercial and Industrial Wastewater" provides the legal foundation for preventing the entry of toxic and damaging substances and liquids to Jordan's public sewer. The act provided specific prohibitions on toxic chemicals, petroleum products, dense slurries, and excessive hot, alkaline or acidic discharges. Because of the necessity of agricultural reuse of some wastewater, a list of the maximum concentrations of heavy metals that could be disposed of was included in the rules. Recommendations for the maximum salinity, measured as TDS, of discharges to sewers were also included in the 1988 version of the law. A copy of the current law is attached in Appendix A.

By 1998, it was clear that some updates and revisions on the 1988 law concerning industrial and commercial discharges to sewers were needed. The Water Authority of Jordan called for revision of the rules and several other government offices were invited to attend deliberations on the subject. Several improvements to the standards resulted from the discussion. These included the refinement of the list of heavy metal concentrations allowed in discharges to sewers and specific limitations to concentrations of pollutants and toxins based on experience in Jordan. The new standard also included a practical provision allowing industries with waste liquids with high BOD and COD to make

discharges to the sewer. The revised rules allowed these materials to be discharged to the sewer under a calculated fee that included a surcharge for the high content of organic materials.

The 1998 revision to the rules makes it possible for any industry to obtain a connection to the sewer for that portion of their wastewater that meets the quality requirements of the revised discharge standards. The Water Authority of Jordan recognized that industries that were denied sewer connections were likely to dispose of some materials by clandestine discharges to municipal sewers from tanker trucks or hoses. Most of those concerned believed that it would be better to allow connections even when there was some risk of toxic discharges. In this way, some revenue could be collected and large and damaging toxic shock loads that result from tankers unloading waste materials into the sewer could be reduced.

3.2 Jordan Standard 202/1991 for Industrial Wastewater

In 1991 Jordan's Department of Standards and Metrology published a standard for discharge of industrial wastewater after extensive discussion with the Water Authority of Jordan, the Ministry of Health, the Ministry of Planning and many others. The 1991 law superceded the 1983 martial law on industrial wastewater discharges. The standards include a set of criteria for the quality and treatment necessary for wastewater discharged to various receiving waters, to irrigation or for groundwater recharge.

Standard 202 incorporated the World Health Guidelines for the reuse of industrial wastewater that included four categories:

- Irrigation
- Artificial Recharge of Groundwater
- Discharge to the Sea
- Discharge to Wadis, Rivers and Catchment Areas

The irrigation reuse standard did not specify limitations on BOD but it limited the fecal coliform to 1000 most probable number of fecal coliform per 100 ml of treated wastewater. Boron, a heavy metal that limits plant growth, was limited to concentrations of one part per million (1 mg/L.) Standard 202 recognized the problem of salt in reclaimed wastewater to be used in agriculture -- a limit of 2000 mg/l of total dissolved solids was specified and remains in force for industrial effluents.

In developing the standards for wastewater reuse, the Jordanian standard borrowed on the regulations for wastewater reuse and discharge published by the Ministry of Environment and Water Resources in The Sultanate of Oman and experience in discharges to the sea developed in Kuwait.

3.3 Standard 893/1995 -- Discharge Standards for Treated Domestic Wastewater

Prior to 1995, professionals in the Water Authority of Jordan relied on World Health Organization standards for wastewater treatment plant design and effluent control. The usual practice was to obtain a BOD and TSS of 30 mg/l for effluent from treatment plants. By 1995, it was recognized that a comprehensive national standard was needed.

Thus, in 1995, Jordan's Department for Standards published a comprehensive reuse standard for treated domestic wastewater principally developed by the Water Authority of Jordan. These standards are currently applied to all municipal wastewater treatment systems. The standards establish a variable standard for wastewater quality for 7 categories of discharge or direct reuse. The direct use of treated wastewater for the irrigation of crops normally consumed raw was explicitly forbidden by the Standard.

The 1995 Standard # 893 includes the following categories of wastewater reuse standards depending on the fate of domestic wastewater after it is released from the wastewater treatment facility:

- Recycling of water for irrigation of vegetables that are normally cooked,
- Recycling of water used for tree crops, forestry and industrial processes,

- Discharges to receiving water such as wadis and catchment areas,
- Use in artificial recharge to aquifers,
- Discharge to water bodies containing fish,
- Discharge to public parks or recreational areas,
- Use in irrigation of animal fodder.

The 1995 standard enabled design engineers and concerned health officials to adjust the level of treatment and, hence, the cost of treatment to the actual conditions of treated effluent reuse. Standards for BOD were limited to 150 mg/l for most forms of agricultural reuse and a more stringent standard was created for amenity irrigation in areas that can be accessed by the public.

3.5 Jordanian Standard # 1145/1996 -- The Uses of Sludge in Agriculture

In 1996, Jordan's Department of Standards issued a standard for the use and treatment of sludge and septage in Jordan. The standards provide rigorous control on the process of sludge conversion to organic soil conditioner for agricultural use and it limits the places that such converted sludge can be used for soil enrichment. The standards also limit the times during which the digested sludges can be applied to agricultural soils. At present the regulations severely restrict the uses of sludge so that much of the by-product of wastewater treatment is now disposed of by landfill.

3.6 Jordan's Wastewater Management Policy of 1998

In June of 1998, the Ministry of Water and Irrigation and the Prime Minister of Jordan issued a set of strategies and policies on water and wastewater. ***The Wastewater Management Policy of 1998*** was among the official government policies that were issued. The official policy demands that treated effluent be considered as a water resource and not separated in policy or thought from other water resources. It stresses the improvement of the quality of treated effluent by blending with higher quality water. The policy suggests that crop selection should be made to suit the irrigation water, soil type, soil physical and chemical properties, and the economics of reuse operation.

The *Wastewater Management Policy of 1998* institutionalizes 62 points regarding the future use and management of wastewater. The following important assertions were made a part of the national wastewater strategy by the policy:

- Wastewater shall not be disposed of; instead, it shall be a part of the water budget,
- There shall be basin-wide planning for wastewater reuse,
- Use of recycled and reclaimed water for industrial use shall be promoted,
- Fees for wastewater treatment may be collected from those who use the water,
- Any crops irrigated with wastewater or blended waters shall be monitored, and
- Ultimately, the role of the government shall be regulatory and supervisory and private operation and maintenance of utilities shall be encouraged.

4.0 THE FUTURE OF WASTEWATER REUSE STANDARDS AND LAWS

Although much progress has been made in Jordan on laws and standards for wastewater reuse, the critical water situation suggests the need for further evolution of wastewater reuse standards and related law. Due to the expected rapid growth of treated wastewater supplies, it will be necessary for Jordan to expand the agricultural reuse of wastewater and to enhance industrial recycling of water in the future.

Most wastewater treatment plants in Jordan are designed to meet Jordanian Standard 893 with "Discharge to Wadis" being the primary standard. This standard requires BOD reduction to 50 mg/l, presumably for the protection of aquatic environments. In practice, however, discharges typically occur to dry wadis that experience only occasional runoff. BODs as high as 150 mg/l or more are acceptable to most farmers and, in some cases, the costs of treatment could be substantially reduced by the reuse of higher BOD treated wastewater. Similarly, the standard for total suspended solids in the wadi

discharge standard, 50 mg/l may be too rigorous a standard when there is no real threat to aquatic environments. The achievement of 15 mg/l ammonia concentration as nitrogen that is a part of the "Discharge to Wadis" standard is difficult and expensive to achieve. Higher concentrations would have little effect on health or the environment in most circumstances in Jordan where surface water is scarce.

Currently, Jordanain Standards forbid the use of reclaimed water for irrigation of vegetable crops that may be eaten raw like lettuce, tomatoes and onions. In the future, wastewater treatment processes and treated wastewater quality will improve in Jordan and quantities of reclaimed wastewater are likely to grow substantially. Jordan is also making progress in on-farm management of irrigation. Thus, it may be beneficial for Jordan to expand the use of high-quality reclaimed water standard on high-value crops where a good standard of public health can be assured.

The standards for the use and processing of sludge severely limit what can be done with sludge and septage. There appears to be an opportunity for a new standard on sludge use and the conversion of sludge to soil conditioners. Improved standards coupled with careful oversight of commercial companies could lead to a significant industry in the production of safe soil conditioners made from sludge. Regulations for this need to be drafted.

In the longer term, Jordan's standards for wastewater treatment may be amended to achieve even greater flexibility to meet specific conditions of effluent reuse and to control the cost of treatment. Such amendments may include suggested ranges of constituent concentrations in standards rather than single maximums. Collaborative processes for the prudent decision-making on what standard to apply to specific cases could be specified in an advanced set of standards and decision-process for wastewater reuse

The increasing value of reclaimed wastewater and the obligation for improved use of this resource is underlined in Jordan's ***Wastewater Management Policy of 1998.*** In the future, it will be increasingly necessary for wastewater plant designers and planners to carefully consider wastewater reuse as an important part of the planning for wastewater treatment. Thus, concepts for wastewater treatment may be increasingly driven by the need for optimal wastewater reuse. Wastewater treatment plant location, the priority of treatment plant construction, the type of treatment, downstream conveyance and the treatment standard may all be linked to the planned reuse of the water produced. It seems likely, therefore, that the next step will be improved standards and flexible decision-making processes that allow designers to shape the entire wastewater collection, conveyance and treatment design around the anticipated reuse of wastewater.

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